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Structure and Affinities of the Petrified Plants from the Cretaceous of Northern Japan and Saghalien VII
A Petrified Pinaceous Cone from the Upper Cretaceous of Hokkaido

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北日本及びサハリンの白亜紀産石化植物 VII
北海道上部白亜系産マツ科の球果

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Pityostrobus matsubarae sp. nov. is a petrified pinaceous cone from the Upper Cretaceous of Hokkaido. It has helically arranged bract-scale complexes consisting of larger scale with tapering apex and small bract. The scale is two-seeded with a distinct interseminal ridge between the seeds. Studies of vascular and resin canal courses revealed characteristics is unique in any taxa of the Pinaceae, suggesting that *P.matsubarae* exhibits an intermediate morphology between *Pseudoaraucaria* and modern pinaceous genera. (Continued from Nishida et al. J. Jpn. Bot. **66**: 280–291, 1991)

Studies on fossil pinaceous remains from the Cretaceous of Japan were initiated by Stopes and Fujii (1910) who described a petrified wood *Cedroxylon yendoi* Stopes et Fujii from Hokkaido. Stopes and Kershaw (1910) described leaves of *Pinus yezoensis* Stopes et Kershaw and *Prepinus japonica* Stopes et Kershaw. *Abietites yezoensis* Suzuki (1910) is a petrified shoot which is now assigned to *Cedroxylon yezoense* (Suzuki) Shimakura (1937). Since then, many species of the Pinaceae, mostly petrified needles of *Pinus,* have been reported from the Upper Cretaceous of Hokkaido (Ogura 1932, Ueda and Nishida 1982, Stockey and Ueda 1986, Stockey and Nishida 1986). Another petrified leaf of the Pinaceae assigned to *Piceophyllum* was reported by Ogura (1930). All other petrified pinaceous remains from the Upper Cretaceous of Japan are woods belonging to *Piceoxylon* (Shimakura 1937) or *Pinuxylon* (Ogura 1944). In contrast to a large number of vegetative pinaceous remains known to date, there have been no reports of petrified reproductive organs from the Cretaceous or even from the Mesozoic of Japan.

Three genera of petrified pinaceous cones have been reported from the Cretaceous worldwide.

Pinus belgica Alvin (1960) from the Wealden Formation (Neocomian) of Belgium is one of the earliest record. Cones that are not assignable to *Pinus* or any other extant pinaceous genera have been identified with the form genera *Pityostrobus* Nathorst emend. Dutt (1916) or *Pseudoaraucaria* Fliche emend. Alvin (1957b). *Pseudoaraucaria* is considered to be a natural genus judging from the systematic treatment of Recent genera (Alvin 1957b, Miller 1976a). *Pityostrobus* includes all other cones that cannot be identified with any modern genera or with *Pseudoaraucaria*. Compared to the taxonomic criteria used in identifying genera of extant Pinaceae, each species of *Pityostrobus* seems to represent an independent genus (Miller 1976, Stockey 1981).

This paper describes an anatomically preserved pinaceous ovulate cone found recently from the Cretaceous of Hokkaido. This is the first record of petrified ovulate cone of the family from the Mesozoic of Japan.

Materials and methods

Specimen no. 860809 is a coniferous cone anatomically preserved in a sandstone nodule which contains abundant plant fragments. It was collected by Mr. Tomoji Matsubara from Haboro, Hokkaido, without any indication of its exact locality and horizon. In Haboro region the Cretaceous sediments bearing similar fossiliferous nodules occur in the eastern mountainous area (Matsuno and Kino 1960). These sediments which belong to the Upper Yezo Group, are dated as Cenomanian-Campanian based on associated marine fauna (Matsumoto 1977). The cone apex was embedded in the sandstone and its base was missing. The material was cut transversely into two pieces, and micropreparations were made by the cellulose acetate peel technique using 1.8% hydrochloric acid as an etching reagent.

Result

Pityostrobus Nathorst emend. Dutt

Pityostrobus matsubarae, sp. nov.

Diagnosis. Ovulate cone ovoid, about 18 mm in diameter; bract-scale complexes helically arranged on main axis; two seeded; bract 3 mm long; scale 11–13 mm wide, 0.8–1.1 mm thick at widest part; scale apex thin; interseminal ridge apparent between seed cavities; cone axis 1.5–3.5 mm in diameter; pith 240–740 μm in diameter, constructed of thin walled parenchyma cells; vascular cylinder dissected; secondary xylem lacking resin canals; cortex of parenchyma cells containing small resin canals; vascular trace supplied to bract diverging from base of gap of vascular cylinder; vascular supply to scale arising from both sides of gap of vascular cylinder as two strands, join to form ''horseshoe'' shape in transverse outline; one large resin canal present between vascular supplies to bract and scale; several abaxial and one adaxial resin canals in bract-scale complex; several abaxial canals in scale base.

Holotype and deposition. Specimen no. 860809 and micropreparations. Laboratory of Phylogenetic Botany, Chiba University.

Locality and Horizon. Haboro Town, Hokkaido. Precise locality is unknown. Upper Cretaceous (Cenomanian-Campanian?).

Ethymology. Specific epithet is dedicated to Mr. Tomoji Matsubara who collected the specimen.

Description. Cone structure. The complete shape is unknown as the specimen is embedded in sandstone nodule, and the basal part is missing. It seems, however, to be ovoid like *Tsuga* judging from serial cross sections (Fig. 1A). It measures 18 mm at its maximum diameter and at least 15 mm long, but its exact length is unknown. The bract-scale complexes are arranged helically on the cone axis and are about 3.6 mm high and 4.1 mm

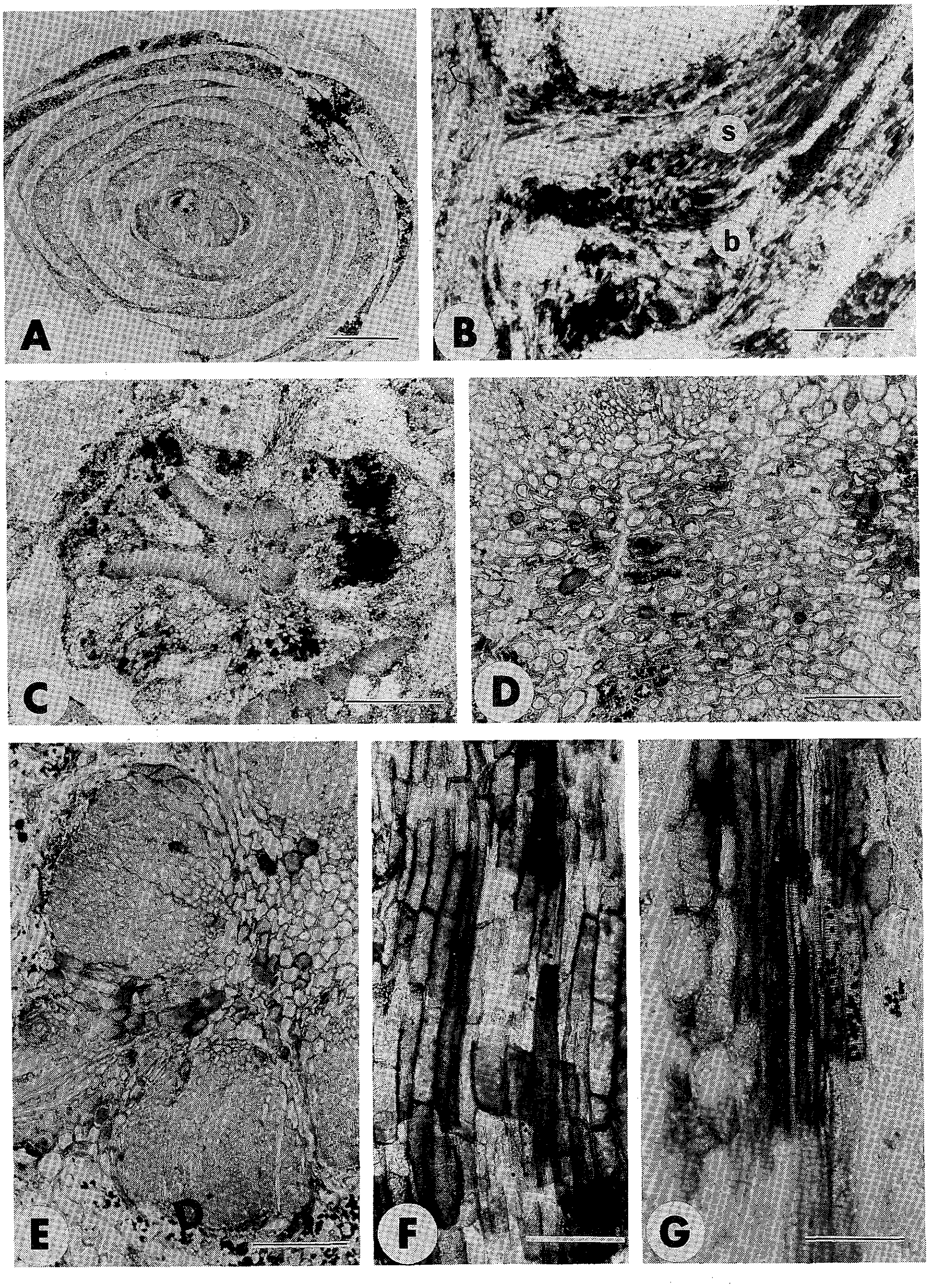

Fig. 1. *Pityostrobus matsubarae* sp. nov. A: Transverse section of cone showing numerous scales. B: Radial longitudinal section of cone axis showing bract (b) and scale (s). C: Transverse section of cone axis. D: Transverse section of the cone axis showing pith and primary xylem strands. E: Transverse section of cone axis showing pith and dissected vascular cylinder. F: Longitudinal section of pith parenchyma cells. G: Longitudinal section of cone axis showing primary xylem tracheids. Scale bars, A: 3 mm, B, C: 1 mm, D, E: 0.2 mm, F, G: 0.1 mm.

wide at the base. Separation of the bract and scale occurs at about a third from the base of the complex to the bract tip (Fig. 1B). The bract is about 3 mm long, whereas the scale is at least 10 mm long from its base to the middle (Fig. 1B). The scale is 1.7 mm wide and 1.8 mm thick at its base, but is widest in the middle of its length where it measures 11–13 mm wide and 0.8–1.1 mm thick. The scale apices are thin but not paperly.

Cone axis. The cone axis (Fig. 1C) is 3.5 mm in diameter at the base of the specimen and decreases to 1.5 mm near the apex. The pith is 240–720 μm in diameter (Fig. 1D, E, F). It is constructed of elongated parenchyma cells that are polygonal with rounded corners in transverse section, measuring 19–43 μm in diameter and 142–409 μm in length and with walls 2–5 μm thick.

The vascular cylinder is 240–600 μm thick and consists mostly of secondary xylem (Fig. 1E). It is weakly dissected by narrow gaps continuous from the wider gaps formed with elaboration of bract and scale traces (Figs. 1E, 5). Primary xylem strands are visible at the inner edge of the cylinder (Fig. 1E). Tracheids of the primary xylem which have helical or annular secondary wall thickenings (Fig. 1G) are 10–19 μm in diameter and their walls are thin, measuring less than 2.4 μm thick. Tracheids of the secondary xylem are 12–36 μm in diameter with walls 5–7 μm thick. Bordered pits are not observed. Rays are uniseriate and 1–5, mostly 1–2 cells high. There are no resin canals in the secondary xylem.

The cortex, which encloses the vascular cylinder, is 340–840 μm thick, and is constructed of thin-walled parenchyma including scattered thick-walled cells. Both types of cells are 24–53 μm in diameter. The walls of thin-walled cells are less than 2.4 μm thick, those of thick-walled cells up to 10 μm thick. Sclerenchyma cells are not present in the cortex. The hypodermis consists of 4–6 layers of somewhat thick-walled small cells that are 19–26 μm in diameter (Fig. 2A). Epidermal cells are rarely preserved, measuring 13–29 × 12–19 μm in dimensions in cross section. About 13 resin canals, 120–294 μm in diameter, occur in the cortex of the base of the specimen. They decrease in number to 5–6 near the apex.

Each vascular trace to bract and scale diverges independently from vascular cylinder of the cone axis (Figs. 2C, D, 5). Bract traces depart from the bottom of gap in the axial cylinder. Scale traces diverge as two independent strands from both sides of the gap in the vascular cylinder of the cone axis. They measure 40–45 μm × 70–75 μm in tangential longitudinal sections of the cone axis. The two strands soon unite to make a horseshoe-shaped strand (Figs. 2E, 5). The small spaces surrounded by bract and scale traces are filled with small amounts of parenchyma and include a large resin canal that is 123–142 μm × 304–323 μm in tangential sections (Figs. 2B, C, D, E, 5). This canal is not continuous with those in the cortex. Except for this blind canal, two large resin canals, which measure 380–522 μm in diameter, diverge from pair of resin canals running vertically along both sides of the gap. Each of the two canals subsequently divides in a vertical plane into a bract canal and a scale canal, and becomes 180–285 μm in diameter (Fig. 5).

Bract and scale. The bract and scale project from the cone axis as a single fused unit (Fig. 1B). The ground tissue is composed of parenchyma cells that are 31–60 μm in diameter with walls of 2.4 μm thick and scattered sclerenchyma cells that are as large as parenchyma cells and with walls of 7–12 μm thick. The tissue abaxial to the bract trace is constructed of larger parenchyma and sclerenchyma cells, which are up to 95 μm in diameter and walls of sclerenchyma are up to

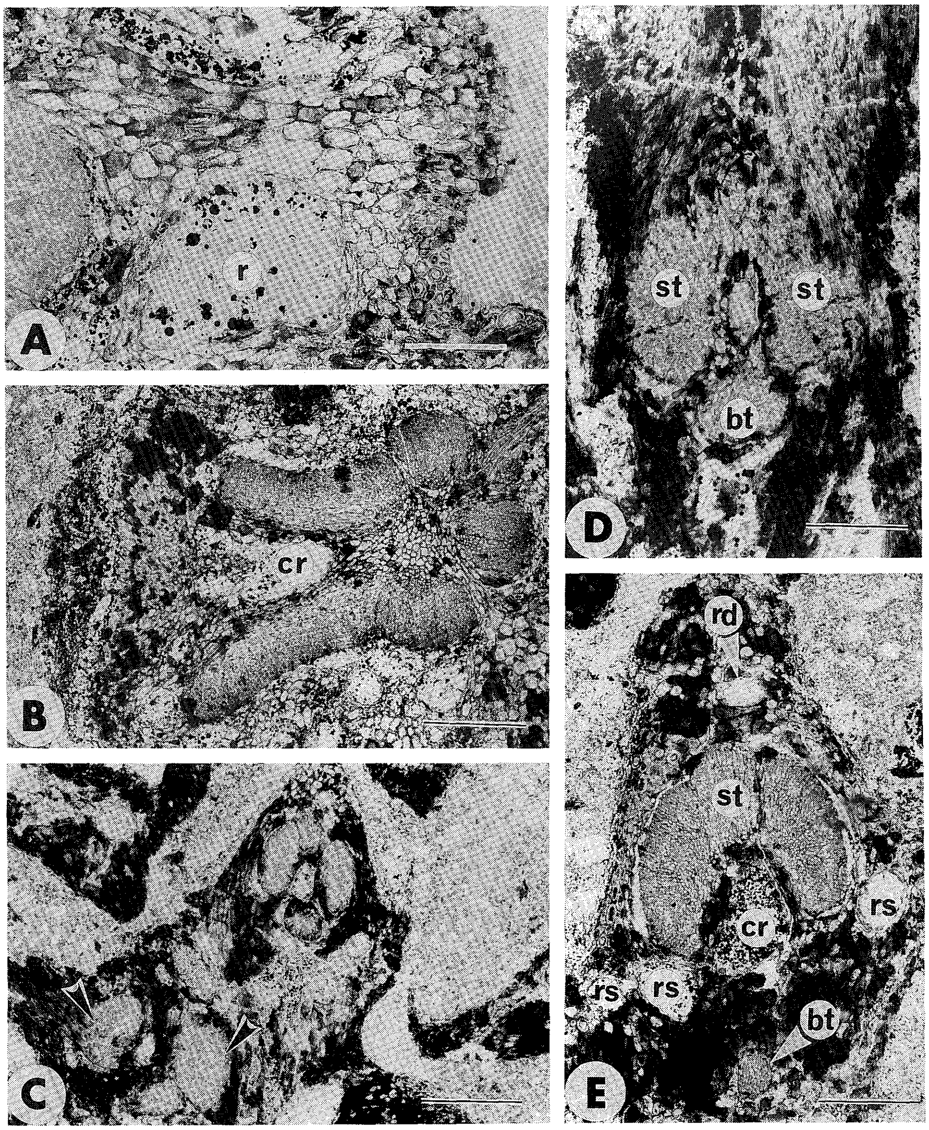

Fig. 2. *Pityostrobus matsubarae* sp. nov. A: Transverse section of cone axis showing a resin canal in the cortex (r). B: Transverse section of cone axis showing a resin canal (= central resin canal, cr) in the space surrounded by diverging bundles entering as scale traces. C: Tangential longitudinal section of cone axis (= section cut vertically to the bract-scale axis) showing base of bract-scale complexes each supplied with two scale traces (arrows). D: Tangential longitudinal section of the cone axis showing base of bract-scale complex. Notes two scale traces (st), bract trace (bt) and a central resin canal. E: Transverse section of base of bract-scale complex showing vascular strands and resin canals supplying the scale. Scale traces unite to form a horseshoe-shaped unit. Resin canals derived from the axial canals (rs) start branching before central canal (cr) divides. Single resin canal (rd) occur in the adaxial to the scale trace (st.) Scale bars, A: 0.2 mm, B, D, E: 0.5 mm, C: 1 mm.

12–24 μm thick. The tissue adaxial to the scale trace, except for the tissue at the top of interseminal ridge, is composed of fibers measuring 26–83 μm in diameter and having walls of 7–19 μm thick (Fig. 3A). The tissue at the top of the interseminal ridge is constructed of thin-walled, small parenchyma cells that are 24–60 μm in diameter with walls less than 2.4 μm thick.

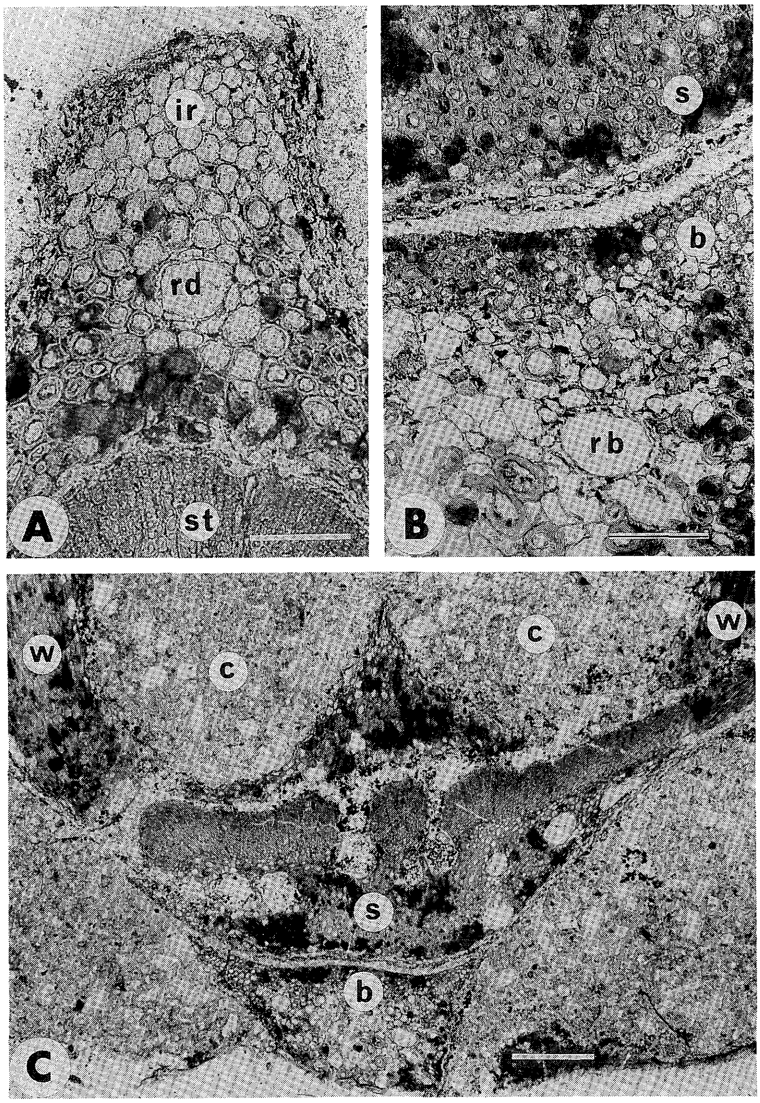

Fig. 3. *Pityostrobus matsubarae* sp. nov. A: Transverse section of bract-scale complex showing a resin canal (rd) in interseminal ridge (ir). B: Transverse section of scale (s) and bract (b) bases showing histological details. One of bract resin canals (rb) is shown. C: Transverse sections of scale base (s) and bract (b) showing wing-like extensions (w) holding two seed cavities (c). All, upper side adaxial. Scale bars, A, B: 0.2 mm, C: 0.5 mm.

As the bract-scale complexes broaden distally, the scale trace extends laterally. A dense group of small thick-walled cells is observed between the bract and scale traces. The tissues of both lateral margins and interseminal ridge remain parenchymatous.

A small resin canal measuring about 100μm in diameter and surrounded by about eight epithelial cells occurs in the interseminal ridge (Figs. 2E, 3A). This canal disappears in the base of the scale or in the bract-scale complex. The connection of this adaxial canal with cortical canals cannot be confirmed because of poor preservation.

Of the three canals entering the abaxial side of the scale, the lateral canals divide first (Fig. 2E), and then the central blind one branches in more distal sections. Bract canals at either side of bract trace do not divide.

Separation of the bract and scale occurs laterally first and extends medially in more distal sections. The bract has a small, centrally located bract trace. The bract trace disappears soon after the bract separates from the scale. Two resin canals that measure 114–133 μm in diameter are present in each side of the trace (Fig. 3C). The ground tissue of the bract consists of thin-walled parenchyma and scattered sclerenchyma cells (Fig. 3B). Parenchyma cells are 43–93 μm in diameter with walls about 2 μm thick. Sclerenchyma cells are 36–86 μm in diameter with walls 10–24 μm thick. The hypodermis consists of two or three layers of thick walled cells that are 19–40 μm in diameter with walls 7–10 μm thick. A dense group of small thick-walled cells, which is continuous from the similar tissue occurring between the bract and scale traces in the bract-scale complex, is present on the adaxial side of the bract trace at the point of separation of the bract and scale (Fig. 3B). These cells are replaced by thick-walled hypodermal cells in more distal sections.

The ground tissue of the scale base consists of thick-walled fibers (Fig. 3B, C). Fibers in the medial region are 28–72 μm in diameter and their walls are 10–24 μm thick. Both lateral margins of the scale are constructed of larger thick-walled fibers which measure 48–96 μm in diameter and have walls 20–34 μm thick. These fibers construct lateral wing-like structures subtending the seed cavities (Figs. 3C, 4C).

The ground tissue of the middle area of scale consists of thin-walled parenchyma cells including some sclerenchyma cells (Figs. 4E, F). Parenchyma cells of the abaxial side are 35–59 μm in diameter, and those of the adaxial side are slightly larger, 40–112 μm in diameter with walls less than 2.4 μm thick. Sclerenchyma cells are 40–60 μm in diameter and have walls 14–17 μm thick. The hypodermis consists of small thick-walled cells that are 31–60 μm in diameter with walls 7–12 μm thick.

In the scale base five to seven resin canals, 123–256 μm in diameter, are arranged in a horizontal line abaxial to the vascular strand (Fig. 3C). There are two to three resin canals that measure 86–152 μm in diameter in each wing-like structure (Fig. 4D). In the middle of scale, fifteen to twelve resin canals of various size, 86–295 μm in diameter, occur more or less delineated along the contour of the vascular strands (Figs. 4E, F, 6). Larger canals tend to occur in the tissue between the vascular strands.

Dissection of the vascular strand begins opposite to the two central resin canals and the vascular strand divides into a central small strand and two lateral larger strands between which the resin canals enter (Figs. 3C, 4A). Then they divide into 15–17 strands that are arranged in a curved line in the central area (Figs. 4E, 6).

Two seeds probably occur per one scale, judging from the position of seed cavities (Figs. 3C, 4B). Only one seed, however, was actually found in the cavity (Fig. 4C). Endotesta is constructed of one layer of parenchyma cells. Sclerotesta is 124–218 μm thick, constructed of sclerenchyma cells. Sarcotesta and seed wings were not preserved. There are no resin cavities in the seed coat.

Discussion

Comparison to Recent genera *Pityostrobus matsubarae* exhibits following characters: 1) Scale is dominant, subtended by small bract, and has tapered apex. 2) Vascular supplies to the bract and scale diverge separately from the vascular cylinder of the cone axis. 3) Vascular supply to the scale

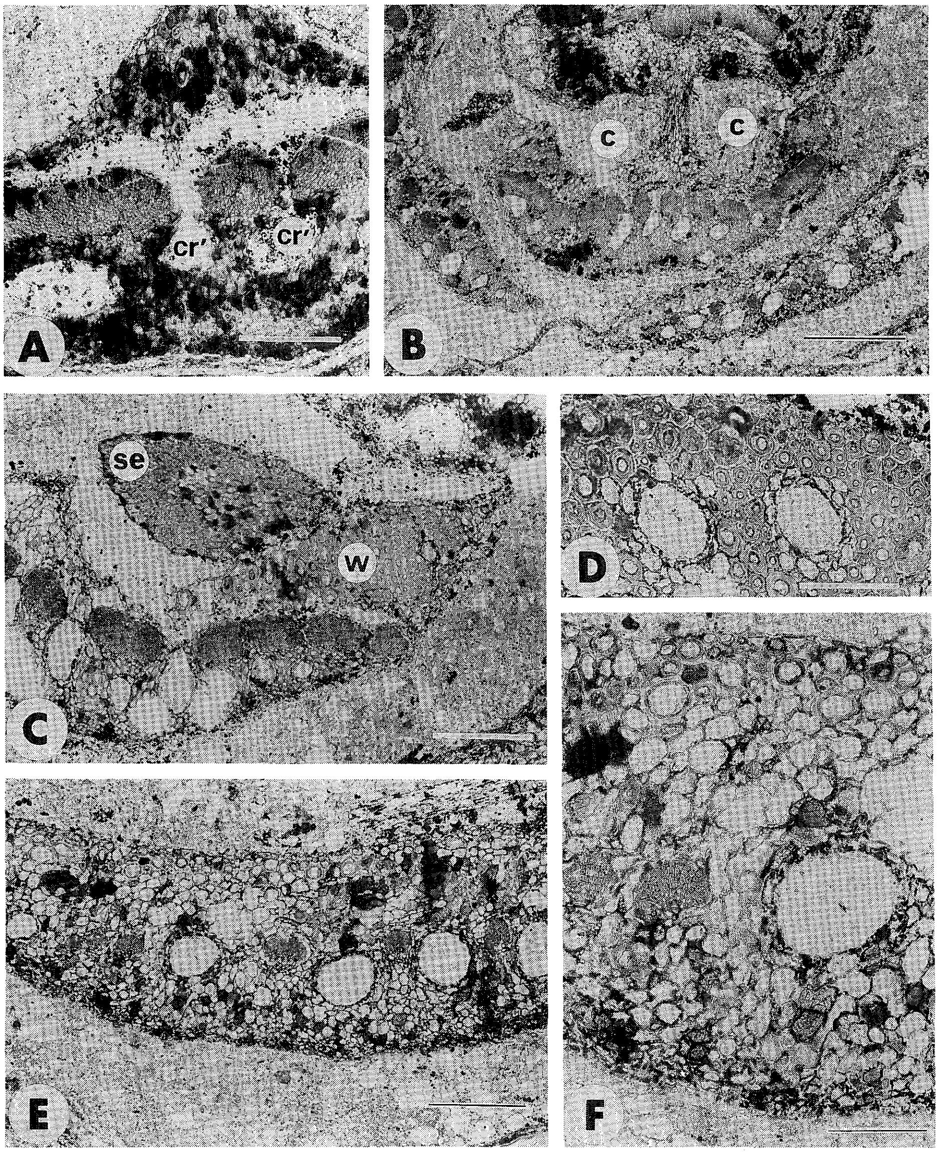

Fig. 4. *Pityostrobus matsubarae* sp. nov. A: Transverse section of scale base showing two resin canals (cr') originated from a central canal and moving toward gaps between separated scales. B: Transverse section of a scale with two seed cavities (c). C: Transverse section of a scale showing a wing-like projection (w) subtending a seed (se). D: Enlargement of a wing-like projection of the scale showing two resin canals with several epithelial cells. E: Transverse section of scale showing arrangements of resin canals and vascular strands. F: Enlargement of E. All, upper side adaxial. Scale bars, A, C, E: 0.5 mm, B: 1 mm, D, F: 0.2 mm.

arises as two independent strands. 4) One large, blind resin canal occurs in the ground tissue surrounded by vascular bundles to the bract and scale. 5) One adaxial and several abaxial resin canals are present in the base of bract-scale complex. 6) Separation of the bract and scale initiates from bract margins. 7) Two resin canals occur in the bract. 8) A massive interseminal ridge occurs between the seed cavities. 9) Wing-like structures composed of fibrous tissue represent lateral margins of the scale. 10) There are no resin cavities in the seed coat.

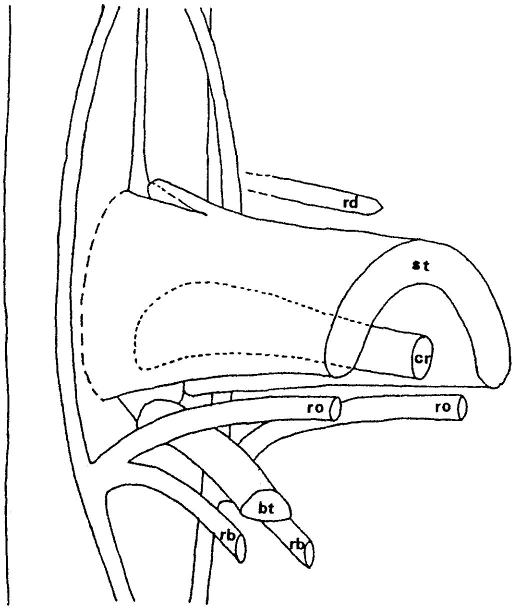

Fig. 5. Diagrammatic reconstruction of the vascular and resin canal supplies to the bract-scale complex. cr, central resin canal; rd, resin canal in the adaxial ridge of scale; rs, lateral resin canals entering the abaxial side of scale; rb, abaxial resin canals entering bracteal scale; st, scale trace; bt, bract trace.

Pityostrobus matsubarae seems to belong to the Pinaceae in having two seeds per scale and a small bract that is almost free from the scale. There are 12 genera in the Pinaceae: *Abies, Cathaya, Cedrus, Hesperopeuce, Keteleeria, Larix, Nothotsuga, Picea, Pinus, Pseudolarix, Pseudotsuga,* and *Tsuga* (Page 1990). Of these, *Cathaya* and *Nothotsuga* are endemic to China and their cone anatomy has never been studied. *Hesperopeuce* is a monotypic genus formerly included in Tsuga and we have no anatomical information on that genus. Hence we compare *Pityostrobus matsubarae* with the rest nine genera.

Pinus is considered to have four characteristics which are not known or quite unusual in other genera: inflated apices of the scales; vascular supplies to the bract and scale diverging as a single fused unit; resin canals in the scale base restricted abaxial to the vascular strand; and scale strands strongly concaving to the adaxial side (Radais 1894, Alvin 1960, Miller 1969, 1973, 1974, 1976a, 1978, Miller and Malinky 1986, Underwood and Miller 1980, Banks et al. 1981, Stockey 1983, 1984). None of these characteristics occur in *Pityostrobus matsubarae* suggesting its distant relationship with *Pinus.*

Abies, Larix, Picea, Pseudotsuga, and *Tsuga* differ from *Pityostrobus matsubarae* in having resin canals restricted adaxial side of the scale trace in the bract-scale complex (Radais 1894, Miller 1976a, Suzuki 1985). *Keteleeria* and *Pseudolarix* differ from *Pityostrobus matsubarae* in having several abaxial and adaxial resin canals in the bract-scale complex or in the scale base (Radais 1894, Miller 1976a).

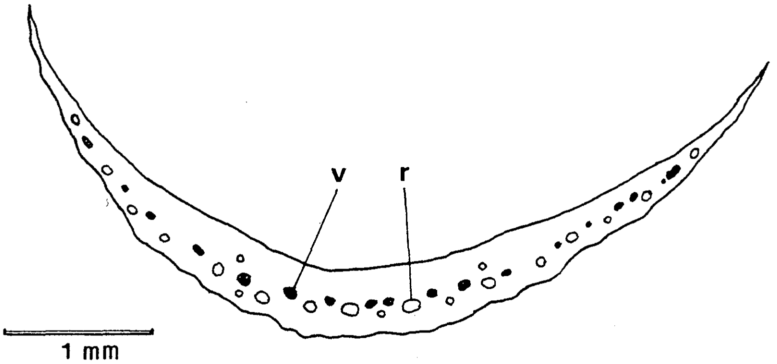

Fig. 6. Arrangement of vascular strands (v) and resin canals (r) in the middle portion of the scale.

Among 11 extant genera, *Cedrus* most closely resembles *Pityostrobus matsubarae* in having a single adaxial and several abaxial resin canals in the bract-scale complex or in the scale base. *Pityostrobus matsubarae,* however, differs from *Cedrus* in the number of vascular supply to the scale, which is two in *P. matsubarae* and one in *Cedrus. Cedrus* lacks a large blind resin canal surrounded by vascular traces to the bract and scale, which characterizes *P. matsubarae. Pityostrobus matsubarae* does not seem to have any closest allies in the extant genera of the Pinaceae.

Comparison to petrified cones Recent taxonomic treatment of the pinaceous petrified cones have included cones that cannot be identified with any extant genera in the form genera *Pseudoaraucaria* or *Pityostrobus* (Dutt 1916, Alvin 1957b, Miller 1976a). *Pseudoaraucaria* is a structurally uniform genus (Alvin 1957b, Miller 1976a), which is characterized by highly dissected vascular cylinder of the cone axis, scales consisting of basal stalk portion and sharply upturned distal portion, pair of seeds separated and overarched by an interseminal ridge, vascular supplies to the scale arising from the axial vascular cylinder as two independent strands that subsequently unites to form a very weak, semicircular strand, and scale resin canals restricted to the adaxial side of vascular strand in the scale base. *Pityostrobus matsubarae* contrary has nearly complete vascular cylinder of the cone axis, a horseshoe-shaped vascular supply to the scale, and abaxial resin canals in the scale base.

Pityostrobus includes all fossil specimens which cannot be compared to extant genera nor *Pseudoaraucaria,* and about two dozen species have been described from the Cretaceous and Tertiary of Europe and North America (Miller 1976a). The occurrence of resin canals in both adaxial side and abaxial side of the bract-scale complex of *Pityostrobus matsubarae,* is quite unusual among the species of *Pityostrobus.* Only two species, *P. cornetii* (Coemans) Alvin (1953) from the Lower Cretaceous of Belgium and *P. ramentosa* Miller (1976b) from the Lower Cretaceous of California, have both adaxial and abaxial canals in the scale base. *Pityostrobus ramentosa,* however, usually has two adaxial canals that divide to provide many adaxial canals in the distal portion of the scale. In *P. matsubarae* a single adaxial canal fade out in the bract-scale complex or in the scale base. *Pityostrobus cornetii* is reported to have one adaxial and several abaxial canals in the scale base. Though there is some doubt in the presence of the adaxial canal in *P. cornetii* due to poor preservation, *P. matsubarae* most closely resembles *P. cornetii. Pityostrobus matsubarae,* however, differs from *P. cornetii* in the number of vascular traces from the cone axis. The vascular trace to the bract and scale of *P. cornetii* diverge independently from vascular cylinder of the cone axis, but the scale trace forms a cylindrical unit as in that of *Keteleeria* (Radais 1894, Miller 1976a).

A single large resin canal occurring in the ground tissue surrounded by traces of the bract and scale is unique diagnostic character of *Pityostrobus matsubarae.* Such resin canal placement does not occur in any extant or extinct pinaceous taxa. Thus *P. matsubarae* is designated as a new species of the genus.

Affinity The affinities of *P. matsubarae* within the family seem to be interesting. The scale trace in mature cones of extant genera of the Pinaceae always arises as single strand (Miller 1976a). Juvenile cones of all genera of the Pinaceae except for *Cedrus* reveal two vascular supplies to the scale (Lemoine-Sebastian 1975). Lemoine-Sebastian (1975) illustrated for *Cedrus* only one vascular strand that further divides to supply all traces in the scale. It does not seem that *P. matsubarae* has an affinity with *Cedrus*, though both resemble in the resin canal placement. The scale vascular supplies of *P. matsubarae* that arise as two independent strands may suggest its affinity with *Pseudoaraucaria*, which also shows this characteristic (Alvin 1957a, 1957b, 1960, 1988, Miller and Robison 1975).

The affinity of *P. matsubarae* with *Pseudoaraucaria* is also suggested by the presence of prominent interseminal ridge in both taxa. As in *P. matsubarae*, some species of *Pseudoaraucaria* have resin canals in the interseminal ridge like *Pityostrobus matsubarae* (Alvin 1957a, 1957b, 1988, Miller and Robison 1975). *Pseudoaraucaria* was considered relatively primitive in the Pinaceae (Miller 1985). This suggestion was supported by a recent cluster analysis by Alvin (1988) using 22 cone characters. Two stranded vascular supplies to the scale occurs in early developmental stages of extant cones (Lemoine-Sebastian 1975) suggesting that this feature can be regarded primitive in the Pinaceae. Considering rather primitive character state of *Pseudoaraucaria*, *Pityostrobus matsubarae* having features similar to the former is regarded as representing one of the extinct forms of the Pinaceae. *Pityostrobus matsubarae* probably has derived from some species of *Pseudoaraucaria* or its close relatives through modification of resin canal placement which became similar to that of *Cedrus*.

Pityostrobus pubescens Miller (1985) from the Late Cretaceous of New Jersey shows a number of *Pseudoaraucaria*-like features as well as many modern features found in extant genera except for *Pinus*, and is considered to be their evolutionary intermediate form. *Pityostrobus matsubarae* less resembles *Pseudoaraucaria* than *Pityostrobus pubescens* does in having fewer common diagnostic features. The highly dissected vascular tissue of cone axis appearing as separate bundles, resin canals restricted to the adaxial side of the vascular trace in the scale base, and a small scale trace with semicircular outline are features common to both *Pseudoaraucaria* and *Pityostrobus pubescens*, but do not occur in *P. matsubarae*. In this respect, *P. pubescens* is closer to *Pseudoaraucaria* than *Pityostrobus matsubarae* is. *Pityostrobus pubescens*, however, is not the ancestral form of *P. matsubarae* in that a single semicircular strand supplies the scale. Both probably are independent derivatives from *Pseudoaraucaria*.

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要旨

北海道羽幌町から松原友治氏が採集した球果は，卵型で最大径18㎜に達する．種子を二個つけた大型の種鱗とそれを腋生する小さな苞鱗は，ほぼ完全に分離しており，明らかにマツ科の球果である．果鱗複合体の樹脂道は，種鱗維管束の向軸側に一本，背軸側に多数あり，現生の *Cedrus* と同じ配列をしている．しかし球果軸の中心柱から二本の独立した維管束として分出する種鱗跡や，大型の interseminal ridge は，*Cedrus* との類縁を否定し，絶滅属の *Pseudoaraucaria* との類縁を示唆する．

種鱗の維管束と樹脂道の配列の組み合わせが，マツ科のあらゆる分類群でこれまで知られていないため，ほかのどの属にも当てはまらないマツ科の球果化石がすべて含まれる絶滅属・*Pityostrobus* の新種，*P. matsubarae* と名付けた．本邦初の中生代のマツ科の石化球果である．